THE EXPLOSIVES ENGINEER

REG. U. S. PAT. OFF.

Forerunner of Progress in Mining, Quarrying, Construction

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Views and opinions expressed by the authors of articles in this publication are their own, and they do not necessarily represent those of the publisher.

Not long ago, tungsten ore was virtually a drug on the market, the mineral nobody wanted. Recent advances in aviation design, particularly in jet engines, have reversed the trend and tungsten has become more eagerly sought after than gold.

Today, more than 30 per cent of the tungsten produced in this country comes from the Pine Creek mine of United States Vanadium Company, located in the high Sierras, 25 miles above Bishop, California.

An outline of the activities at the property in the early days and a description of the mining and processing methods as developed and perfected by the U.S.V. organization in realizing a production of more than 650 tons of ore a day are presented in the article beginning on page 39.

° ° °

With production averaging more than 5,000 tons each eight-hour day, the mining and processing of sodium chloride for commercial purposes by International Salt Company at Retsof, New York, have contributed substantially to the rapid advancement of industry in the United States.

The deposit being mined is a flat seam of rock salt averaging 9½ ft. thick. The panel room-and-pillar system of mining is used. This permits about 70 per cent extraction, with 30 per cent remaining in the pillars. After a working face in a room is undercut at the bottom and sheared at the sides, the salt is drilled and blasted. A 30 per cent low-density ammonia dynamite is used in the blasting procedures. The blasted salt is loaded onto 6½-ton mine cars by means of electro-hydraulic power shovels.

An account of the activities at Retsof mine is given in the article which begins on page 49.

The rapid growth of communities in arid sections in the western part of Texas and New Mexico has caused a serious water shortage. To meet the emergency, the Colorado River Municipal Water District of Big Spring, Texas, has set up an ambitious program of pipeline construction projects designed to bring additional supplies of water to these dry areas in the southwest.

One such project recently completed involved the excavation of a trench 5 ft. deep and 4.25 ft. wide at the bottom, and the laying of a pipeline in it for a distance of 90 miles. In 28 of the first 40 miles of work progress, a formation of caliche limestone was encountered, necessitating drilling and blasting operations. The use of Hercomite° 4 dynamite in the blasting operations produced consistently excellent results.

Further details concerning the successful completion of this hard-rock construction job will be found on page 45.

° ° °

Mining in the Clover Splint mine of Closplint Coal Company at Closplint, Harlan County, Kentucky, is carried on in a seam of coal that averages 46 in., ranging from a low of 36 in. to a high of 56 in. The coal is free from impurities and does not require cleaning before being shipped to the company's customers in this country and some foreign lands.

Using an explosives loading ratio of 1 lb. of Red H°C permissible powder to each 11 tons of coal in place, a large percentage of lump sizes of coal is obtained. This is important to the successful operation of this mine because the great majority of the company's customers specify lump coal.

Please turn to page 53.

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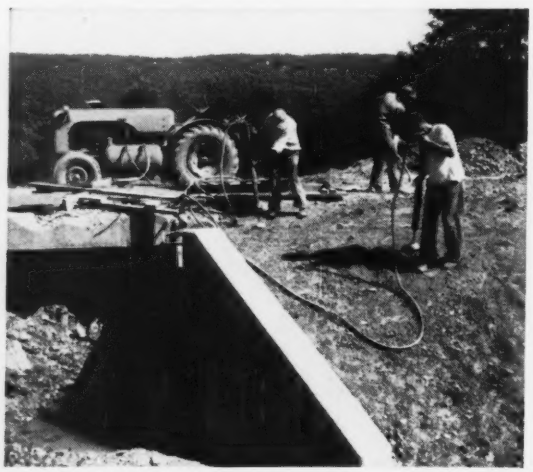

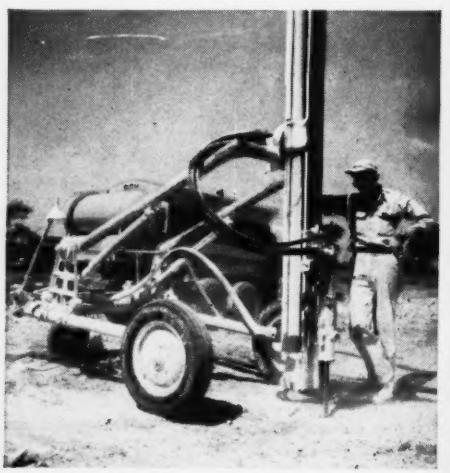

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There are 9 sizes of Airmasters — and 14 models—ranging from 60 cfm to 600 cfm. A 600-cfm diesel unit is shown here. It's got the capacity to operate two deep-hole wagon drills with plenty of air to spare for other tools.

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C-145

Joseph Hamilton Thompson

PRESIDENT

THE M. A. HANNA COMPANY

A Biography

JOSEPH H. THOMPSON, or Joe Thompson, as he is known to friends, sits at the center of one of the most significant and spectacular developments now going on in the mining world. He is not only president of The M. A. Hanna Company with its extensive interests in coal, ore, docks, and shipping, but he is also president of Iron Ore Company of Canada, an organization through which, under Hanna leadership, American and Canadian steel interests are cooperating in the development of the ore resources of Labrador.

From the standpoint of money invested, the Labrador project ranks as one of the larger mining ventures of all time. It includes the construction of the longest railroad built to date in this century, the only railroad whose construction was wholly dependent upon airplane deliveries of men, equipment, and materials to the project location.

In connection with its Labrador development, the Iron Ore Company of Canada operates the largest private air lift in history, having transported 45,000 passengers and 52,000,000 pounds of freight in 1952 alone. Naturally, Mr. Thompson spends a great deal of time in and over Labrador – often as much time as he spends at his desk in Cleveland.

He joined The M. A. Hanna Company with a banking background, but most of his work with the Hanna Company has been in operations rather than in finance. It was his idéa to buy the war transport *Marine Robin*, cut it into sections on the East Coast, reassemble and reconstruct it on the Great Lakes, and thus give to lake shipping the largest vessel sailing on fresh water. The ship now bears the name, and quite appropriately, *Joseph H. Thompson.*

Joe Thompson was born in Nashville, Davidson County, Tennessee, October 29, 1900. His father, for whom he was named, was also a banker. Joe prepared for college at Georgetown Preparatory School in Washington, D. C., and upon graduation, matriculated at the University of Notre Dame. His attendance at the University was interrupted in 1918 when he enlisted in the United States Marine Corps. At Notre Dame his studies were in the field of commerce.

His first employment was with the Union Trust Company of Cleveland, where for over eight years he advanced through various banking positions. In 1929, he made the first of several moves to other banking institutions in Cleveland – serving first as vice president of the Cleveland Trust Company, then later as vice president of the National City Bank of Cleveland. In 1936, he became first vice president of the National City Bank of Cleveland. He joined The M. A. Hanna Company in 1937, and was elected president in 1952.

In addition to his duties as chief administrative officer of The M. A. Hanna Company, Joe Thompson is chairman of the board of directors, Hanna Coal & Ore Corporation; president and director of Butler Brothers, Hanna Iron Ore Company, Hanna Ore Mining Company, and of Iron Ore Company of Canada. He is a director of American Ship Building Company, National Steel Corporation, and National City Bank of Cleveland.

His clubs include the Union, the Tavern, and the Kirtland Country in Cleveland; the Duquesne in Pittsburgh; and the Rolling Rock in Ligonier, Pennsylvania.

Joseph Hamilton Thompson married Elizabeth Lacey on September 21, 1921, in Nashville, Tennessee. They have two daughters: Lacey Thompson Neuhaus and Mary Thompson Clark. The family home is on Metcalf Road, Willoughby, Ohio.

Like many other successful executives, Mr. Thompson finds relaxation from the demands of his diversified business interests in outdoor sports of all kinds, with particular emphasis on hunting and fishing, golf, and tennis.

JOSEPH HAMILTON THOMPSON

Editorial

Dynamite Consumption in 1952 Established New Record

Preliminary estimates indicate that the consumption of dynamite in the United States in 1952 approximated 726,000,000 pounds. This huge total represents the largest consumption in any one year to date, an increase of 7,000,000 pounds over the previous record total of 719,900,000 pounds consumed in 1951.

An analysis of the 1952 dynamite consumption figure reveals that the mining of coal required 32.6 per cent of the total – about three-quarters in underground mines and one-quarter in strip mines. Metal mining consumed 21 per cent, much of which was used in the open-pit mining of copper and iron ore. The production of nonmetallic minerals, including stone from mines and quarries for industrial uses, accounted for 22.7 per cent. Construction, including seismic exploration activities and the recovery of petroleum products, used 21.8 per cent. Other uses, not segregated into specific classifications, required 1.9 per cent.

Forecasts for 1953 indicate that production schedules of industry in general, and the mineral industry in particular, will be continued at or near the present high levels. Explosives manufacturers can be depended upon to maintain an uninterrupted flow of dynamite to the nation's mines, quarries, and construction projects to meet the demands of their operating programs.

U. S. Mineral Production at Highest Rates in History

The U. S. Bureau of Mines' year-end summary reveals that the mineral industry in the United States continued to operate in 1952 at the highest production rates in history. The total value of last year's production approximated $13.5 billion, the same as 1951.

The output of most of the minerals showed increases, notably crude petroleum and aluminum. The petroleum producers registered another record year with 2.3 billion barrels of crude valued at the wells at $5.8 billion, representing more than 40 per cent of the value of all minerals produced in this country last year. Aluminum output recorded a spectacular advance of 12 per cent over the 1951 production figure.

The increases were offset, however, by declines in the production of coal and iron ore. Bituminous-coal was down 13 per cent from the 1951 figure, accounted for, primarily, by a two-month work stoppage in the steel mills and a decline in overseas exports. Anthracite was 6 per cent below the 1951 figure, with a decrease in export business a contributing factor. The supply of iron ore in 1952 was reduced as a result of the shutdown of the steel plants. This brought about a heavy loss of production during the peak of the mining season. Extraordinary effort on the part of the producers helped in overcoming the effects of the shutdown, and adequate stocks of ore were made available for Lower Lake consumers' winter needs.

At present, the country is operating at a consistently high value of output. The requirements of industry and the demands of our defense program indicate a continuance of high production rates for an indefinite period.

1953 Coal Show in Cleveland May 11 through May 14

The 1953 Convention and Exposition of the American Mining Congress will be held in Cleveland, Ohio, May 11 through 14, with headquarters in the Public Auditorium. Mining men and manufacturers' representatives from all over the country, and some foreign lands, will get together for discussions of what has been done, how it was done, and what the future may hold.

The program has been arranged by practical operators and manufacturers of mining equipment, machinery, and materials, with R. E. Salvati, president of Island Creek Coal Company, as committee chairman. At the convention sessions and special group meetings, leaders of the industry will talk on practical mining problems and related subjects, to be followed by a question-and-answer period.

Practically everything that manufacturers have to offer for the safe and economical mining and preparation of coal will be on display in the huge auditorium, much of it in actual operation. Several large exhibits will be shown on the outside. Trained technicians with wide experience in mines and preparation plants will be on hand to answer questions and to discuss particular problems.

With a capacity crowd expected, hotel accommodations will be at a premium. All reservations are being handled by the Cleveland Housing Bureau, 511 Terminal Tower, Cleveland 13, Ohio. If you plan to attend this four-day convention and exposition, and have failed to make a hotel reservation, we urge you to communicate with the Housing Bureau without delay.

Don'ts for Explosives Users

Don't store explosives anywhere except in a magazine which is clean, dry, well-ventilated, properly located, substantially constructed, and securely locked.

Don't allow leaves, grass, brush, or debris to accumulate within twenty-five feet of an explosives magazine.

Don't allow persons under eighteen years of age to handle or use explosives, or to be present where explosives are being handled or used.

Don't leave explosives lying around where children can get them.

U.S.V.'s PINE CREEK MILL: A view of the mill and adjacent buildings at Pine Creek, as seen from the Zero level of the mine. Present production averages more than 650 tons of ore a day.

UNITED STATES VANADIUM'S TUNGSTEN MINE

IN CALIFORNIA

A summary of mining and milling operations that make possible a production of more than 650 tons of ore a day

ROBERT LEE BEHME*

Not long ago, tungsten ore was virtually a drug on the market, the mineral that nobody wanted. Recent advances in aviation design, particularly in jet engines, have reversed the trend. Tungsten is now becoming more eagerly sought after than gold.

The Far East, once the source of much of the available tungsten, is now ruled out. As the demand for tungsten increases, it is natural that America should turn to its domestic resources. It is equally natural that the companies which continued operations during the slack periods should now reap the benefits.

This is one of the reasons United States Vanadium Company's tungsten mine at Pine Creek, California, is so successful. Today, more than 30 per cent of the nation's output comes from this mine. Located in the high Sierra Nevada, 25 miles above Bishop, California, the mine has a long history, during which time methods of production have been perfected.

The exact date when the property was discovered is not known. M. B. Sherwin, an early California surveyor, spent many years prospecting along the rocky ridges of the Sierras. On one of his trips, he located the Pine Creek mine as a silver-lead mine. His interest did not last and, as a result, activities

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Hollywood 46, California

DIAMOND DRILLING: Two miners operating diamond drills are drilling holes for blasting in a drift near the top of a stope.

at the site were of short duration.

In 1916, the mine was reopened by two other prospectors, Sproule and Vaughn. The samples they brought to Cooper Shapley, the local assayer, ran 1½% WO_3 – the mineral scheelite. As a result of the assays, Shapley became interested in the property and, in the same year, he promoted the formation of Pine Creek Tungsten Company. Unfortunately, the venture was ill-fated, for in 1919 the tungsten market hit a slump. With no outlet for its product, the company was forced to close the mine.

The mine lay idle until 1924 when it was reopened by Tungsten Products Company. This firm constructed a 125-ton mill and began the production of scheelite and copper concentrates. Production at the mine began to increase, and in 1925 the company produced 24,983 tons of ore. No effort was made by the operators to push production beyond that figure, their principal concern being a greater percentage of recovery. Beginning with 0.53 per cent WO_3 in 1925, they hit a high of 0.64 per cent in 1926. Shortly afterward the tungsten market again hit a slump and the mine was closed.

U.S.V.'s Pine Creek Operations Began in 1936

Again the mine lay idle and remained so for the next ten years. In 1936, United States Vanadium Company acquired the property. For several years U.S.V.'s crews worked in the existing high-altitude open pits at the top of the mountain range. Eventually, the company drove an adit at an altitude of 10,800 ft. This was the first tunnel operation at Pine Creek and was designated "A" level.

By 1941, when A level was in full production, a manpower shortage gripped the nation and its effects were felt at Pine Creek. U.S.V. shifted from shrink stoping to diamond-drill blasthole methods to compensate for the

EXPLORATORY DRILLING: Exploratory drilling is a continuous operation in all sections of the mine. The work is done by a local concern under contract.

lack of skilled miners. The change worked well. Even with less manpower, the crews rapidly outran the company's development work. Exploratory crews began a search for new ore bodies. In drilling operations below A level, they found a rich extension of the lower ore body.

Plans were made to develop this body and, by 1943, U.S.V. was ready to begin the driving of a new adit at an elevation of 9,300 ft., 1,500 ft. below A level. The development of the lower level, called "Zero" level, was not planned to supplant A level operations, but to augment them. The crushing plant and an adjacent building were located at A level and work was to continue there.

Fire on "A" Level

On February 6, 1949, fire broke out at A level. Heavy snows blocked all attempts to get fire-fighting equipment to the blazing area. The fire threatened to sweep into the mine, and shed buildings leading to A level adit were demolished to save the mine. Even this quick action failed to keep the flames from destroying loading terminals and adjacent buildings.

After the damages from the fire had been thoroughly investigated, U.S.V.'s management personnel decided to abandon operations at A level. At the same time, they set up a program for the construction of additional structures on Zero level to provide facilities for expanded operations in the future.

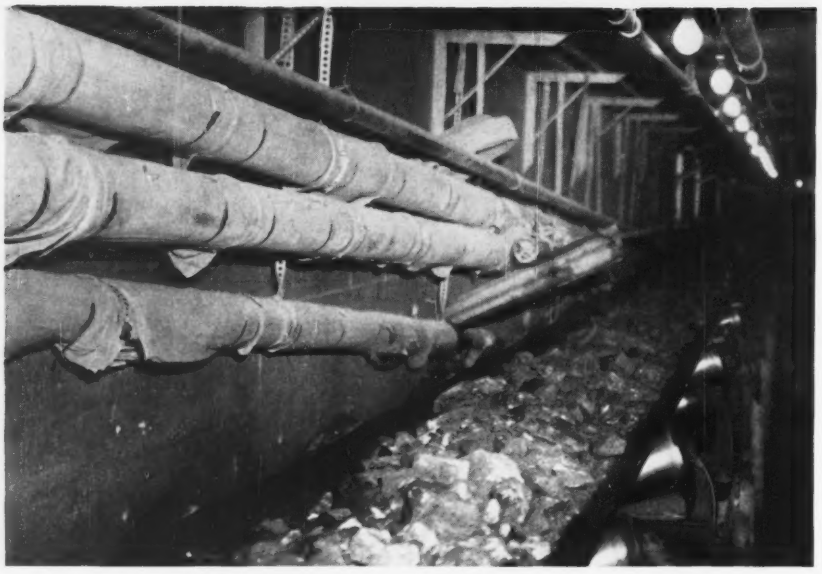
Since the completion of preliminary work in 1951, United States Vanadium has advanced development at every opportunity. As the market for tungsten grew, Pine Creek mine was ready to keep pace with the increased demand. It was this faith in the future that made possible its present production of more than 650 tons of ore a day.

Pine Creek's Ore Bodies

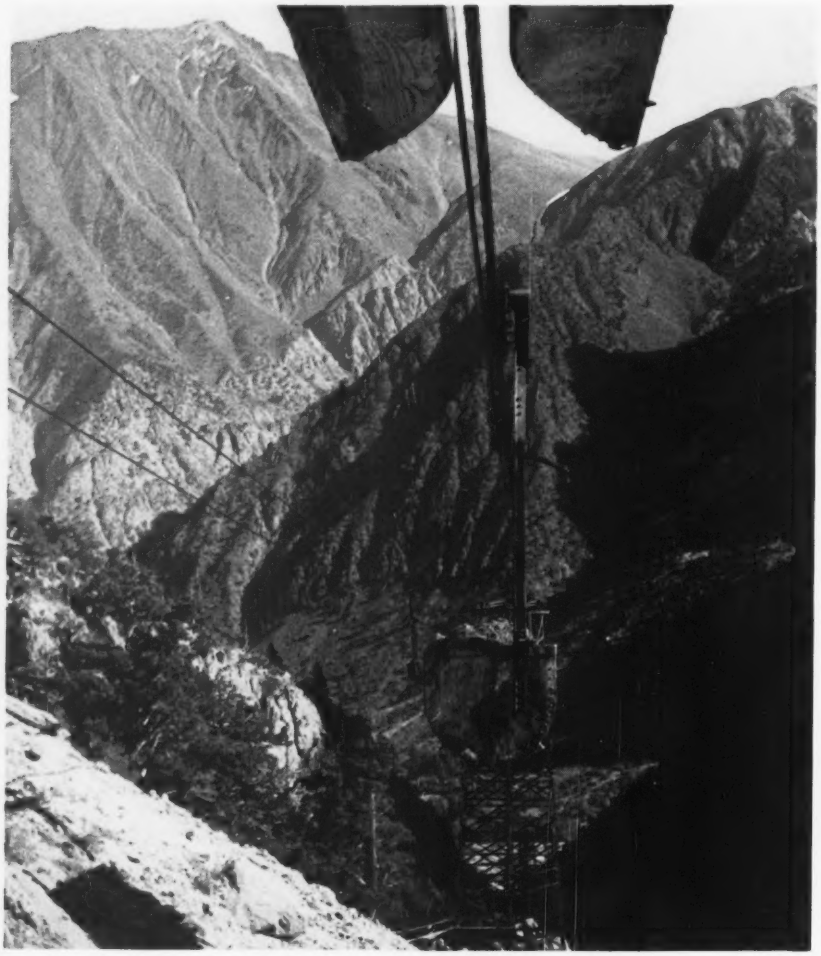
The tungsten deposit at Pine Creek is of the contact metamorphic type, with scheelite-bearing tactite lying between granite and limestone. The strike of the ore body is north-south, with granite to the west and limestone to the east. The contact zone consists of garnet-diopside tactite, quartz, and quartz-feldspar minerals.

SLUSHING MUCK: Muck is slushed from the bottom of scram drifts to Chinaman chutes by means of 50-hp. double-drum slusher hoists.

FEEDING A GRIZZLY: Mine cars filled with ore are unloaded at the rotary dumper for deposit into a hopper feeding to a grizzly.



THE CONVEYOR BELT: After passing through a jaw crusher, the ore is discharged onto a conveyor belt for delivery to the storage bin.



THE TRAM LINE: Below the storage bin, the ore is fed by pan feeders into 1¼-ton tram buckets for the long aerial trip to the mill.

Although the bodies are irregular in size value, they are large enough to be mined separately. They have sharp limits and do not seem bordered by large tonnages of marginal-grade ore bodies. Scheelite is the major tungsten mineral at Pine Creek, but considerable tungsten occurs in powellite $Ca(Mo,W)O_4$. Molybdenite is present, as is chalcopyrite containing gold and silver, and the copper minerals. Because the ore is rich in such minerals, the Pine Creek story is twofold. It is a story of careful mining practices, supplemented by an excellent development program plus a high recovery in the company's mill.

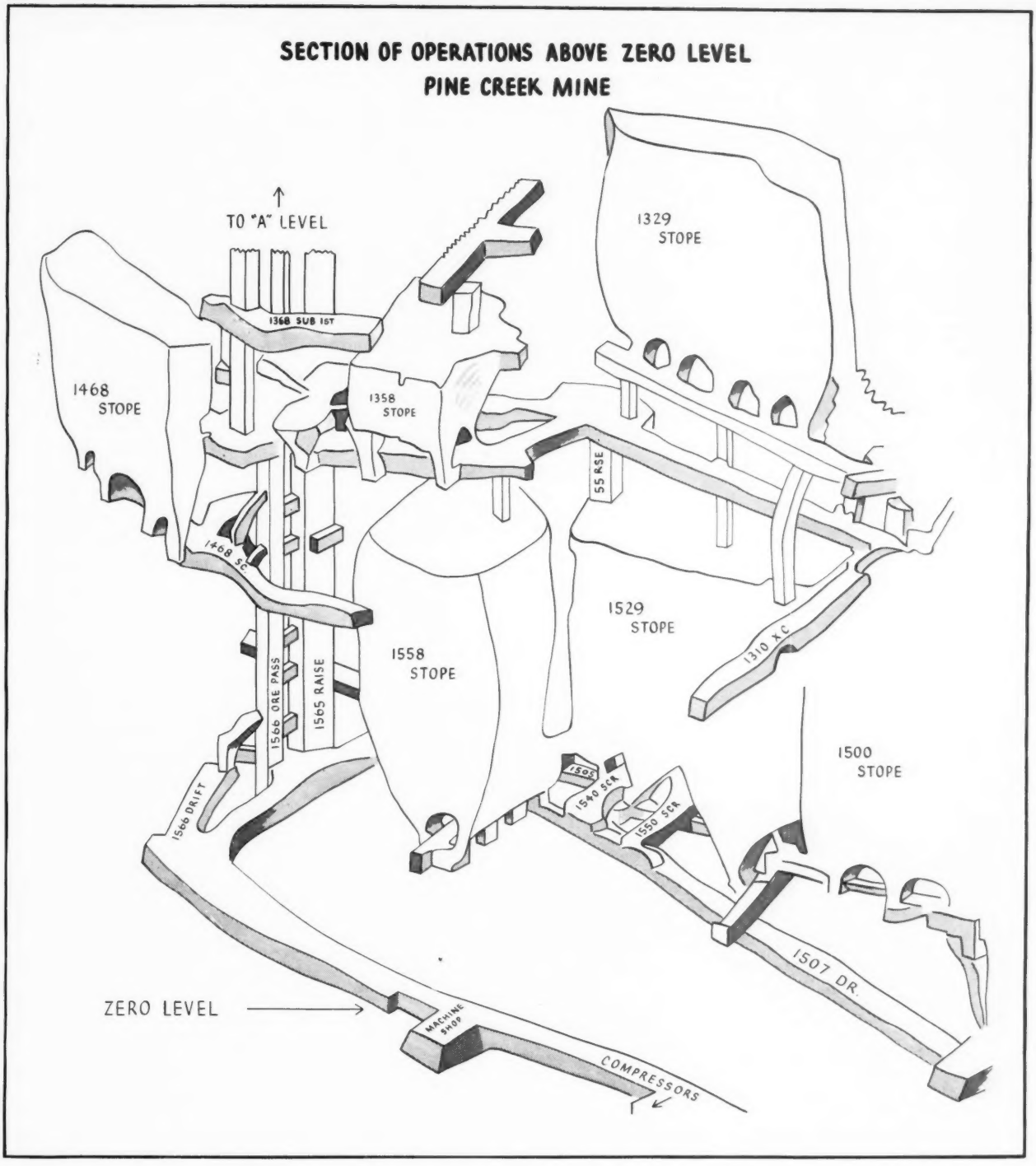
Mining Operations

The first part of the story begins at the mine. Development of the lower ore body began with the adit at Zero level. Initially, the driving of the adit was done by contract. Later, the company took over the work. When the adit had been driven 7,000 ft. from the portal, at a point almost directly below A level, compressor stations and machine shops were located in excavations in the rock.

Development work and mining operations started at the sill of Zero level and progressed rapidly until today there are seven stopes in operation. Beginning at an elevation of 9,434 ft. and extending almost 600 ft. to the "900" level, the stopes will soon be augmented by additional raises which will connect the lower level workings with the older A level.

Of the seven stopes now in operation, six are open stopes and one is a shrink stope. Four large stopes, resting at the 9,434-ft. altitude, and extending more than 200 ft. above, may be considered as major stopes. These are inter-connected with a series of scram drifts and cross drifts to carry the mined ore to loading points. Above these major stopes, smaller stopes feed into scram drifts and then directly to the lower stopes.

Exploratory drilling is proceeding in all sections of the mine. It has been let by contract to Palmer and Decker of Bishop, California. All other mining work, including development and blast-hole drilling, is handled by U.S.V. crews. At the time of the writer's visit,



FAITH IN THE FUTURE

Since the completion of preliminary work at Pine Creek mine in 1951, United States Vanadium Company has advanced development activities at every opportunity, as indicated in this isometric drawing. As the market for tungsten grew, Pine Creek mine was ready to keep pace with increased demand. This faith in the future made possible its present mill production of more than 650 tons of ore a day.

IN THE MILL: Diagonal-deck tables, in foreground, separate coarse scheelite from other minerals for further grinding. Digesters and filters are visible at upper right.

they were working on the incentive pay system, which the company and the employes feel produces better working conditions for the men.

Ring drilling is the predominant method of mining sublevel stopes. Half-circle ring patterns from both the sides and bottoms of sublevel drifts are used. Two of the sublevel drifts being worked were selected for inclusion in this article as being typical of the company's procedures. The two chosen were sublevel drift 1458 and sublevel drift 1368.

Sublevel Drift 1458

Sublevel drift 1458, at an elevation of 9,500 ft., feeds direct into 1558 stope, one of the four major stopes. It was drilled with 27 diamond-drill holes ringed around the left side of the drift, from angles of plus 71 degrees to minus 80 degrees. The holes were from 75 ft. in depth at plus 71 degrees to 37 ft. in depth at minus 80 degrees. Crews drilled 1,936 ft. of holes for a blast, averaging 40 ft. of hole per bit. This is about average throughout the mine.

Drifter, stoper, and jackleg drills are used in the mine. Two kinds of drill steel and bits are used with the jackleg drills. The first type is manufactured in U.S.V.'s shops from double-diamond crucible hollow drill steel with detachable 1⅜-in. cross bits and chisel bits. The second type is steel chisel bit integral hex. ⅞ in. The drifters use 1¼ round crucible alloy drill steel threaded with 115 threads. The stopers use 1-in. hex. alloy drill steel with 115 threads and 1⅜-in. bits.

Air for the operation of equipment at all levels is supplied by two compressors located on Zero level, one of 3,000-c.f.m. capacity and the other of 2,000-c.f.m. capacity. They are operated from a 4,160-volt line supplied by a local power company.

Drilling and Blasting

In sublevel drift 1458, the holes drilled near the bottom of the round, at minus 80 degrees, were 85 ft. deep. Nearer the center of the round, at minus 5 degrees, they were 66 ft. deep. At the top of the round, at plus 71 degrees, the holes were 37 ft. deep. They were loaded with charges of semigelatin dynamite in 1¼ by 12-in. cartridges, on a ratio of approximately 0.4 of a pound of dynamite per ton of rock in the solid. Each charge was primed with a short-period delay electric blasting cap. All charges were stemmed to the collar. When ready to fire a blast, the leg wires of the caps were connected in series. Fragmentation from the primary blasts has been consistently excellent.

Sublevel Drift 1368

Sublevel drift 1368, located directly above 1558 stope, feeds into a smaller stope, number 1358, which, in turn, feeds into 1558 stope. Rounds for blasting in sublevel drift 1368 were drilled at the bottom of the drift, extending half the distance up the wall on each side. A round comprised 26 holes extending horizontally on each side. At plus 5¼ degrees, the holes were 37 ft. deep; at 90 degrees, the hole depth was 35 ft. All of the holes were loaded, primed, and detonated in a manner similar to the procedures already described for blasting operations on sublevel drift 1458. Primary blasts are fired from a central control panel located in a lower drift. When not being used to fire a blast, the control panel is locked and the blasting foreman has the only key.

U.S.V.'s management personnel feels that the methods of drilling and blasting in use at Pine Creek offer several advantages. One outstanding example is the employment of short-period delay electric blasting caps to detonate the dynamite charge in primary blasts. Results indicate that they have made possible better initial fragmentation and, at the same time, they have practically eliminated secondary blasting at the scram drift level.

In general, ring-drilling operations begin when three slots are drilled in an ore body. Sublevel drifts are fanned out at right angles to the slots. The ring drilling begins at the two end slots and retreats toward the center raise. When ring drilling was first used, the burden between rings was 4 ft. with 6-ft. spacings between the backs of the holes. This was later changed to 5 ft. and 7 ft. respectively. At the present time, a system of offset rings with a 2½-ft. burden and 14-ft. spacings is used.

Development work proceeds differently from ring-drilling procedure—holes are drilled 1⅜ in. in diameter, 6 ft. deep. A round consists of 46 to 55 holes drilled in 9 by 9-ft. headings. The average number of holes per round is 48.

Long-hole drifter drilling was used experimentally in the early stages. At present it is used only in narrow ore.

(Continued on page 58)

A 90-MILE WATER PIPELINE IN WEST TEXAS

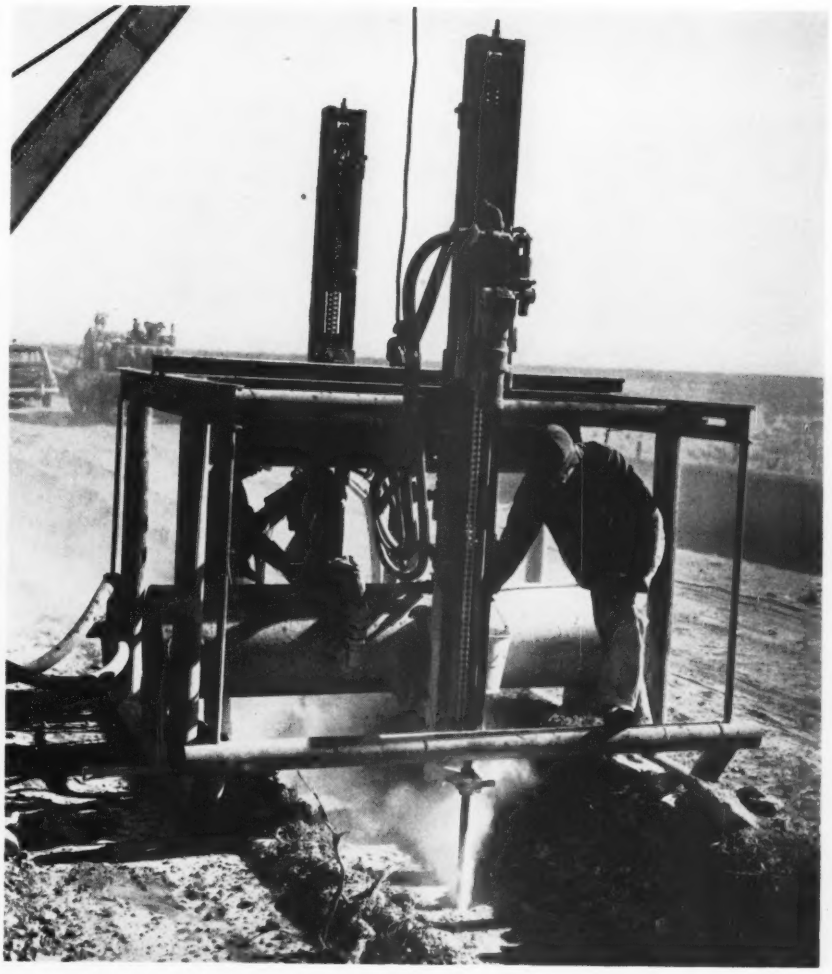
The excavation of a trench 5 ft. deep and 4.25 ft. wide at the bottom included blasting a variable limestone formation along many miles of the right-of-way

JOHN O. SMITH*

THE rapid growth of communities in arid sections in the western part of Texas and New Mexico has caused a serious water shortage. To meet the emergency, the Colorado River Municipal Water District of Big Spring, Texas, has set up an ambitious program of pipeline construction projects designed to bring additional supplies of water to these dry areas in the southwest. One such project recently completed involved the excavation of a trench and the laying of a pipeline in it for a distance of 90 miles to bring water from a newly made lake near Snyder, Texas, to the cities of Big Spring and Odessa. All construction work on the project was done by Sira-McKenzie Construction Company, a combination of Ben Sira & Company, of Dallas, and McKenzie Construction Company, of San Antonio.

Special Drilling Equipment

Starting at the Odessa end and progressing eastward to Big Spring, the right-of-way was cleared and a trench was excavated to a depth of 5 ft., with a minimum bottom width of 4.25 ft. In 28 of the first 40 miles of work progress, a formation of caliche limestone imbedded with layers of hard flint was encountered, necessitating drilling and blasting operations. Holes for blasting



HOLES FOR BLASTING: Two wagon drills mounted on a drill carriage especially built by the contractor were kept busy putting down holes for blasting rock along the trench line.

*Hercules Powder Company
Joplin, Missouri

LOADING DYNAMITE CHARGES: Foreman "Slim" Cochran and his helpers attend to the loading of charges of Hercomite 4 dynamite into the drill holes.

DYNAMITE IN ACTION: Results from primary blasts were particularly gratifying, and mile after mile of trench was excavated without redrilling or reblasting.

the rock were drilled with two Gardner-Denver Model 99 wagon drills mounted on a carriage designed and built by the contractor especially for this project. This drill carriage made possible the drilling of a staggered row of holes with irregular spacings, or a straight line of holes with uniform spacings, to conform with the variations in the rock formations along the trench line. The drills were equipped with 1¼-in. Timken steel and 2½ and 2¼-in. Timken detachable bits. Air for the drills was supplied by a Gardner-Denver 500-c.f.m. compressor. The diameter of the drill holes was 2½ or 2¼ in. with the depth ranging from 2 to 7 ft., depending upon the rock encountered.

Loading the Explosives

Hercomite* 4, in 1¼ by 8-in. cartridges, and Hercomite Bag Powder were loaded into the drill holes, with charges based on an explosives loading ratio of 1.2 lbs. of Hercomite per cu. yd. of rock in the solid. Each charge was primed with Hercules* Electric Blasting Caps with 6 and 8-ft. leg wires. Blasts were fired with a 50-hole blasting machine. In some cases, mats were placed over loaded holes to prevent any of the blasted rock from flying. When this procedure was necessary, Primacord was used as the priming agency for the dynamite charges.

The results from the blasts were particularly gratifying. Mile after mile of the trench was excavated in the rock sections without secondary blasting, or the redrilling and reblasting of high spots.

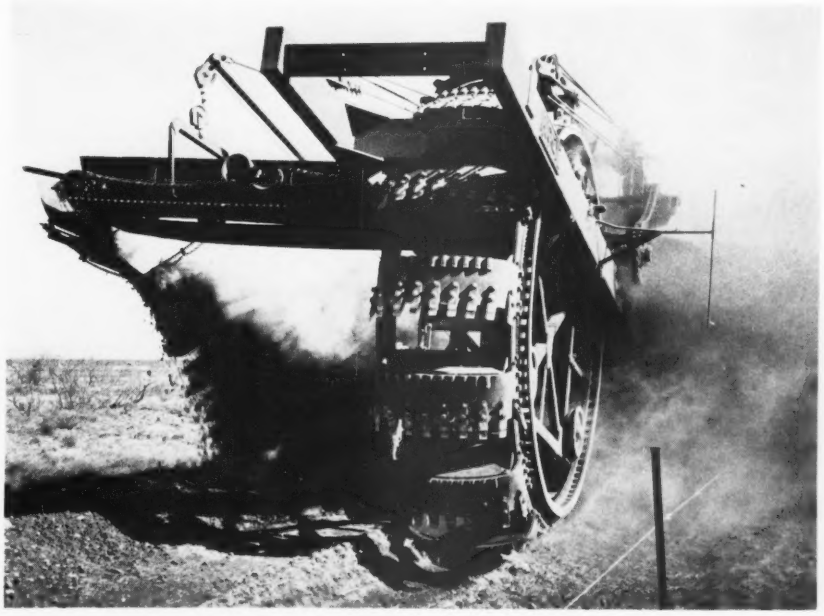
Soft-Ground Operations

In areas where no rock was found, or when overburden had to be removed from rock, excavation was accomplished by means of a Model 51 Buckeye wheel-type ditcher. In the rock sections, excavation was handled by the employment of a Model 605 Koehring with a 1¾-cu. yd. backhoe. In these latter areas, it was not unusual to excavate up to 1,800 ft. of trench in a ten-hour work day.

The pipe laid in the bottom of this 90-mile trench consisted of 31.52-ft. sections of steel cylinder pressure pipe, 27 in. and 33 in. in diameter, lined inside and outside with concrete. It was manufactured and delivered to the job by United Concrete Pipe Corporation of Big Spring, Texas. A Model D8 side-boom Cat was used for laying the pipe, and a Model D7 angle-dozer was utilized in the backfilling operations.

The principal operating equipment used on the project included a Model D8 Cat and an Allis-Chalmers maintainer for right-of-way work; a Model 51 Buckeye wheel-type ditcher; two Model 99 Gardner-Denver wagon

EXCAVATING BLASTED ROCK: Skillful drilling and blasting techniques simplified the rock excavation with a Model 605 Koehring equipped with a 1¾-cu. yd. backhoe.



WHEEL-TYPE DITCHER: In areas free from rock and in rock sections where overburden had to be removed, excavation was accomplished with a Model 51 Buckeye wheel-type ditcher.

*Reg. U. S. Pat. Off.

INSPECTION: Superintendent S. S. Sheffer, left, and Frank Pierce, foreman of excavation and pipe laying, inspect the trench before additional sections of pipe are installed.

MOVING EQUIPMENT: When the drill carriage, the drills, and the compressor had to be moved, the job was done with a Model D8 side-boom Caterpillar tractor.

PROJECT MANAGER: A. R. "Pappy" Martin, vice president of the McKenzie Construction Company, was general manager of operations on the 90-mile pipeline project.

drills; a Gardner-Denver 500-c.f.m. air compressor; a Model 605 Koehring with 1¾-cu. yd. backhoe; a Model D7 Cat for carrying drills and pulling the compressor; a Model D8 side-boom Cat for laying pipe; and a Model D7 angle-dozer for backfilling the trench.

Project Personnel

As indicated previously, this project was completed under the authority of the Colorado River Municipal Water District of Big Spring, Texas, with all work done under the direct supervision of Colonel E. V. Spence, manager of operations for the district. Plans for the project were prepared by Freese & Nichols, consulting engineers, with headquarters in Fort Worth, Texas. The latter company was represented on the project by Martin Rose, traveling engineer. John Cheatham was the resident engineer on the job.

A. R. "Pappy" Martin, vice president of McKenzie Construction Company, was project manager for the contractor. "Our job progressed much more rapidly than anticipated, despite the fact that we ran into more rock than was estimated," Mr. Martin commented. "The excellent results obtained were due, in large measure, to the experience of our key men: S. S. Sheffer, superintendent; J. L. "Slim" Cochran, foreman of drilling and blasting; and Frank Pierce, foreman of excavating and pipe-laying operations."

THE LARGEST Salt Mine IN THE WESTERN HEMISPHERE

With production averaging more than 5,000 tons each eight-hour day, the Retsof mine of International Salt Company supplies a basic raw material for a wide variety of industrial uses

BRADLEY ROOT*

When motorists drive through the town of Retsof, New York, five miles northwest of Geneseo and thirty miles south of Rochester, comparatively few of them realize that the wheels of their automobiles are passing over the largest salt mine in the Western Hemisphere. With production averaging more than 5,000 tons each eight-hour day, the mining and processing of sodium chloride for commercial purposes by International Salt Company, Incorporated, at Retsof, have contributed substantially to the rapid advancement of industry in the United States.

How the salt deposit at Retsof came into being is somewhat of a mystery. Theoretically, it is assumed that during one of the recurring cycles of the earth, an inland sea was formed at a time when the climate was hot and dry. It is believed this inland sea was fed intermittently from the ocean. With the periodic influx of brine and continuous evaporation, layers of salt crystals formed. As time passed, geological earth changes covered and compressed the salt into the underground veins we find today.

*Personnel & Stores Manager
International Salt Company
Retsof, New York

Activities at Retsof began with the sinking of a shaft on August 10, 1884. The salt vein was reached during the following year and the first processed rock salt was shipped a few months later. In 1921, it was recognized that the original plant was reaching obsolescence. On July 6, 1921, a new concrete-lined shaft 9 by 28 ft. was started about one-half mile south of the original shaft and plant. This shaft was sunk vertically to a depth of 1,063 ft. and a new preparation plant was erected nearby. The shaft serves a threefold purpose: one compartment is used for hoisting men and materials; two compartments are used for hoisting semicrushed salt; and all compartments act as their ducts. At present, the mined-out area extends for a distance of about 1,600 acres.

Flat Salt Seam 9½ ft. Thick

The deposit being worked in the mine is a comparatively flat seam averaging 9½ ft. thick. The panel room-and-pillar system of mining is used. Each panel is 500 by 2,400 ft. with 20 rooms to a panel. The rooms are 63 ft. wide and the pillars 57 ft. wide. Each room is about 500 ft. long. The pillars are left in alternating lengths of 220 and 185 ft. by staggering the crosscuts between rooms. This system of mining permits about 70 per cent extraction, with 30 per cent remaining in the

UNDERCUTTING THE SALT: Mining at Retsof begins with the horizontal undercutting of the salt in a room from wall to wall, at the floor level. A shortwall undercutter machine equipped with 11-ft. cutter bars is used in this procedure.

SIDE SHEARING: The next step in mining activities is the making of two vertical shear cuts 6 in. wide by 10 ft. deep, located about 30 in. from the side walls of each room.

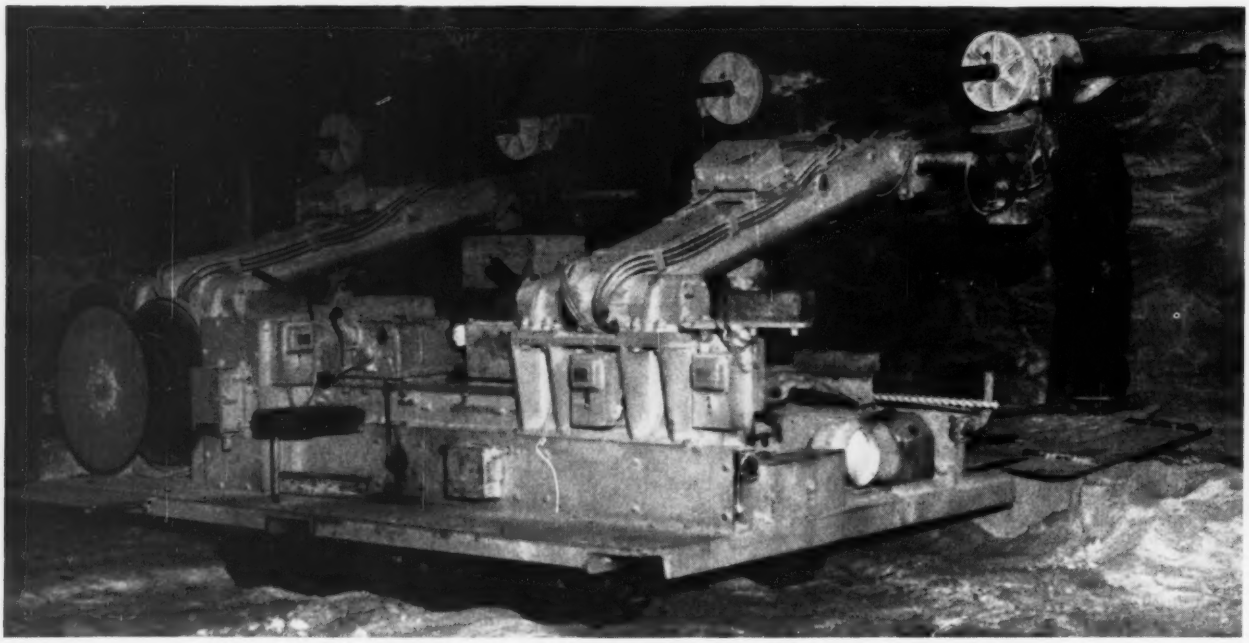
pillars. The floor of the mine follows a uniform dip of less than 1 per cent.

The first operation in the mine involves the horizontal undercutting of a room from wall to wall, at the floor level. This is accomplished by three crews of two men, each of whom operates shortwall undercutter machines equipped with 11-ft. cutter bars. The undercutters are driven by 50-hp. 250-volt D.C. motors. The bits for these machines are made with a mild steel shank tipped with tungsten carbide bits. The bits are inserted in blocks which make up a nine-position cutter chain. All of the machines are equipped with bug-dusters which eliminate hand shoveling of cuttings. They are transported from room to room by a track-mounted carrier, which is equipped with an adjustable ramp to facilitate loading and unloading operations.

The next step in the mining procedure is done with a shearing machine. This unit makes two vertical shear cuts 6 in. by 10 ft., located approximately 30 in. from the side walls of each room. It is caterpillar-mounted and equipped with tungsten carbide-tipped bits and a mechanical cable reel. The machine is operated by two men.

Drilling Blast Holes

After the shear cuts have been made, holes for blasting are drilled by a special caterpillar-mounted machine, electrically operated. Two T-shaped, hydraulically operated arms are mounted on a stationary platform. Two auger-



DRILLING BLAST HOLES: Holes for blasting are drilled with a special caterpillar-mounted machine electrically operated. The special drill mounting makes possible the drilling of four holes simultaneously, each 1¾ in. in diameter and 12 ft. deep.

type rotary drills are mounted on each machine. The mounting of the drills enables the operators to drill four holes simultaneously. The hydraulic control mechanism makes possible the adjustment of the drills to any height between the mine floor and the roof. The machine is equipped with a mechanical cable reel. Four setups are required to drill 60 holes, 1¾ in. in diameter by 12 ft. deep, in four horizontal rows. The auger-type drill steel utilizes 1⅝-in. tungsten-tipped detachable bits. The crew consists of three men.

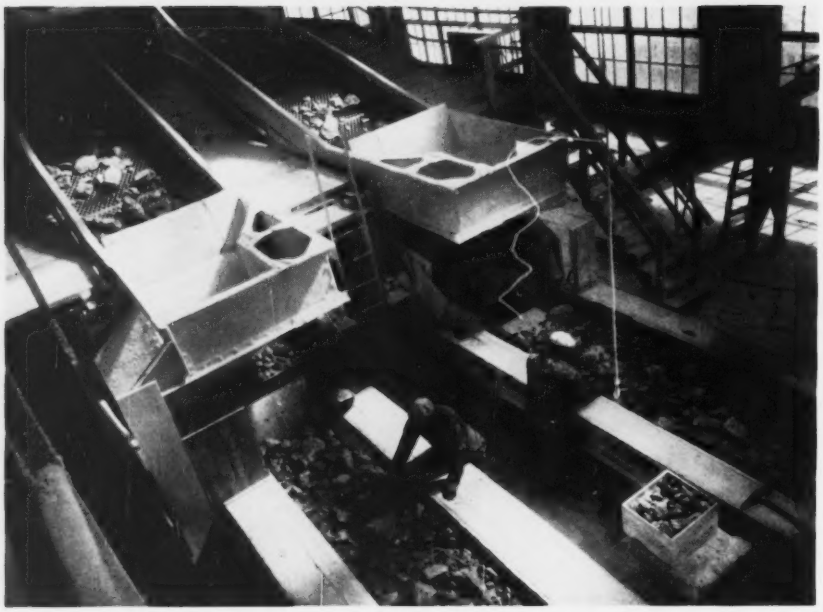
A drill round for a primary blast comprises four rows of holes drilled across the room. The bottom row starts 4½ to 5 ft. above the mine floor, dipping downward to finish at 18 to 24 in. above the floor level. The second row begins approximately 18 in. above the bottom row. The top row starts as close to the roof as the operation of the drills permits, with holes directed upward to finish in the roof. Between each of the three drill rig setups across the face 50 in. is allowed.

AFTER A BLAST: After blasting, the broken particles of salt are loaded into 6½-ton mine cars by caterpillar-mounted electro-hydraulic power shovels. The loaded cars are hauled to a gathering yard by electric locomotives.

Loading Dynamite Charges

All holes are loaded with 1⅛ by 8-in. cartridges of a 30 per cent low-density ammonia dynamite, using an explosives loading ratio of 0.4 lb. of dynamite to 1 ton of salt. The dynamite charges are primed with instantaneous and short-period delay electric blasting detonators, first through fifth delay periods. All of the loaded holes are stemmed with 18-in. tamping bags filled with fine salt. The detonators are hooked up in series parallel, and one leg wire of the cap at each outside hole is connected to a parallel-circuit line. A No. 20 insulated iron wire is used to complete the circuit at the face and to connect with the permanent blasting lines. A No. 14, red-braided duplex wire is used for permanent

MAIN LINE TRACK: At the gathering yard, 15-ton tandem-connected locomotives pick up trips of 50 loaded cars and haul them 2 miles over an 80-lb. main line track to a rotary dump. Locomotives and cars are painted bright yellow to provide good underground visibility.



GRADING THE SALT: At the top of the breaker house tower, skips loaded with salt are discharged. After passing over screens, the salt is deposited onto a conveyor belt for first inspection.

lines. The permanent lines are hooked to a panel-type blasting board located at a safe distance from the area of the blasts. Each panel board setup is complete with eight safety switches, a master switch, and a telephone. When not in use, the connector between the master switch and the safety switches is placed under lock and key. A galvanometer is used to check all blasting circuits. All blasts are fired after the regular shift goes off duty. Switches are kept locked until needed.

Telephone Orders Control The Firing of Blasts

Foremen in charge of blasting are notified by telephone when they may begin to fire. After the all-clear signal has been received by the blasting foremen, a telephoned order is given to have all electric power cut off. The power is not turned on again until after all the lead wires have been connected to the permanent blasting lines and the foremen have reported by telephone that they are ready to fire. Lights indicate when the power is on and, with the closing of the switches, all rounds loaded for blasting are fired.

Because metal particles are objectionable in salt, annealed iron capsule detonators with iron leg wires are used. Each detonator is encased in an aluminum shell. The plastic insulation on the leg wires is colored a deep pink so that they can be clearly seen underground against the salt background.

After blasting, the broken particles of salt are loaded into 6½-ton-capacity mine cars by caterpillar-mounted, electro-hydraulic power shovels. Two of the mine cars are loaded as a unit and hauled to a gathering yard by 8-ton locomotives. At the gathering yard, 15-ton tandem-connected main-line locomotives pick up trips of 50 loaded cars and haul them approximately 2 miles over an 80-lb. main-line track. All of the locomotives are equipped with hydraulic brakes and trolley phones. The mine cars are equipped with automatic couplers. Both locomotives and mine cars are painted bright yellow to provide good underground visibility.

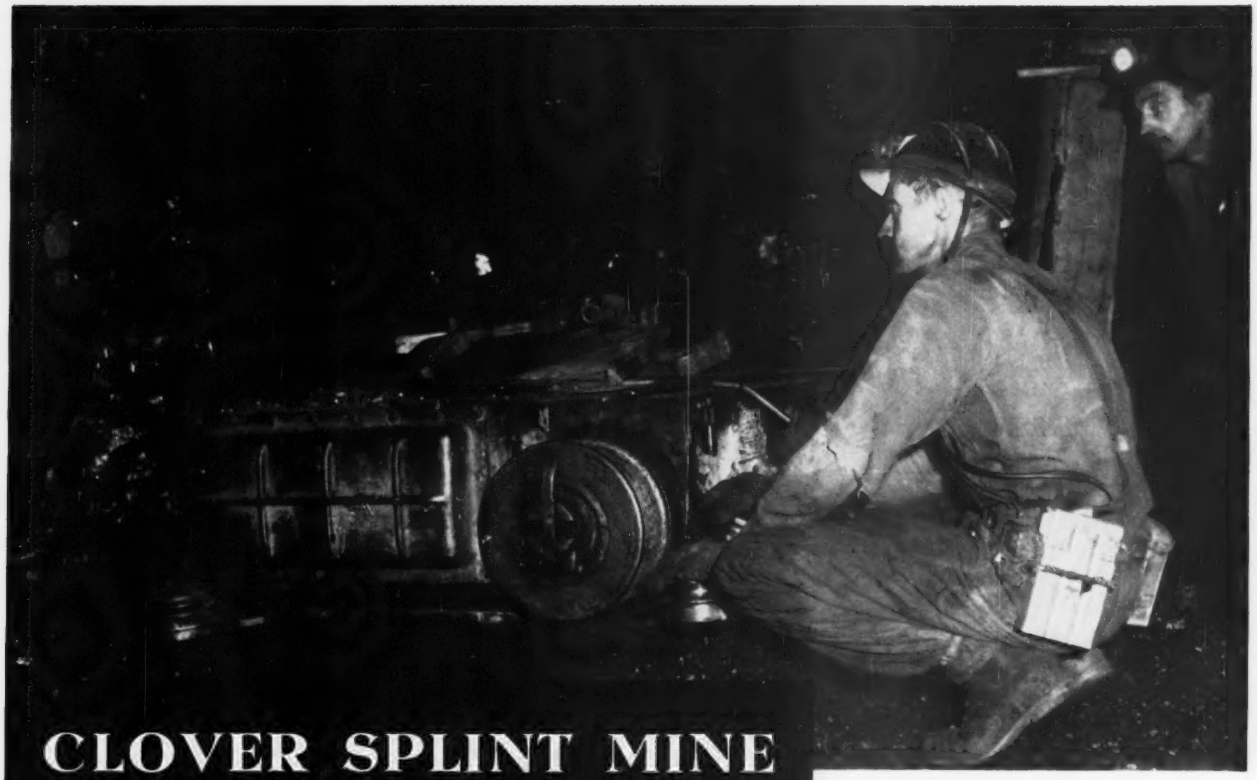
Plant Operations

The loaded cars are emptied by means of a mechanically operated rotary car dump. The cars are fed one at a time onto the dump by an electrically operated reciprocating feeder without uncoupling. After dumping, the broken salt passes over grizzly bars with 8-in. openings. The fines drop through into a divided surge bin while the oversizes tumble into a jaw crusher. The crushed product is deposited into the same surge bin. The salt is then fed into two skips of the bottom-dump type. The skips are hoisted approximately 1,200 ft. and dumped direct into a structural steel hopper with a bulkhead in the center, to separate the discharges from the skips. The skips are hoisted by means of an electric hoist driven by two 600-hp. motors. A 1¾-in. wire rope is utilized in hoisting the skips.

After the skips have been discharged into the hopper, the salt is evenly distributed by reciprocating feeders onto

(Continued on page 59)

CRUSHING THE SALT: The salt flows by gravity from the top of the breaker house to a battery of crushers installed on floors below the primary screens. The crushers reduce the large lumps of salt to the grades required.



CLOVER SPLINT MINE

IN HARLAN COUNTY, KENTUCKY

UNDERCUTTING THE COAL: The coal in rooms 24 ft. wide is undercut and working faces are made ready for the next cycle of operations—drilling, blasting, and loading out of the coal.

Closplint Coal Company's operating procedures produce an average of 1,400 tons of high-quality coal a day

E. DEATON TRENT*

IN 1927, a mine was opened in the High Splint seam of coal at Closplint, Kentucky, in the southeastern part of Harlan County, by three mining engineers from Pittsburgh named Evenson, Alford, and Auchmuty. Operations were conducted under the name of Clover Splint Coal Company, Incorporated, using the hand-loading method of mining. The new venture was located on the Clover fork of the Cumberland River, with the portal at an elevation of 2,915 ft. above sea level.

In 1945, the property was purchased by Pittsburgh - Consolidation Coal Company for operation by Consolidation Coal Company (Ky.), one of its divisions. Soon after the change in ownership and management took place, new, modern equipment and mining methods were introduced and a gradual changeover from hand loading was instituted. At present, approximately 75 per cent of the coal is mined by mechanical methods.

*Hercules Powder Company
301 Fifth Avenue
Pittsburgh 22, Pa.

Closplint Coal Company

Ownership of the property changed hands again on March 1, 1953, when it was purchased by Closplint Coal Company, comprising a group of local men with wide experience in the production of coal from Kentucky mines. The new company management personnel plans to carry on operating procedures similar to the modern methods and equipment employed by its predecessor, Consolidation Coal Company.

Through the years, the safety record at Clover Splint mine has been excellent. Records show more than 2,000,000 tons of coal mined without a fatal injury; 330,000 tons were produced in 1952 with only two lost-time injuries; and reports of federal and state mine inspectors on recent visits stated that no unsafe practices were in force and no unsafe working conditions were present. The new owners will continue to promote and encourage safety in all operations, with no lost-time injuries the goal.

The Coal Seam

The height of the coal seam being mined averages 46 in., ranging from a low of 36 in. to a high of 56 in. It is free from impurities and does not require cleaning before shipment to the company's customers in this country and some foreign lands, for domestic, steam, and by-product uses.

Before mining operations get under

way at a working place, the roof is carefully examined. Any loose material found is dislodged and brought down onto the floor. Large wooden timbers are set into the roof to prevent any further working or movement in the roof. Following the completion of these preliminary details, the coal in rooms 24 ft. wide is undercut and the working faces are made ready for the next cycle of operations – drilling, blasting, and loading out of the coal. In rooms where the mined coal is hand loaded, steel rails are laid to provide tracks for the movement of mine cars into and out of the rooms.

Drilling and Blasting

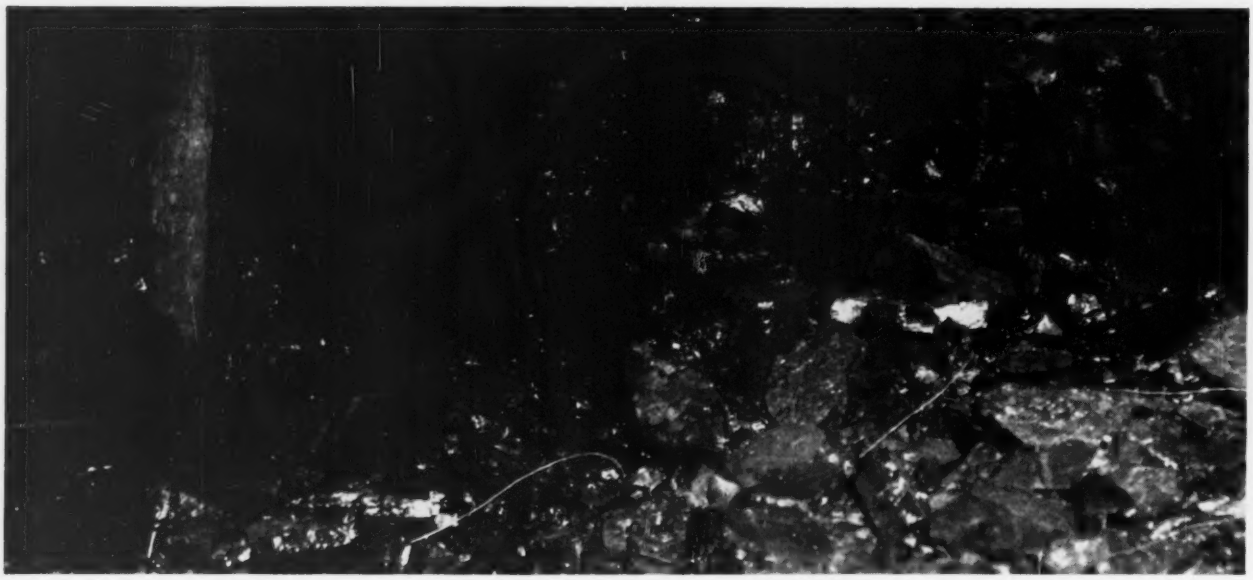
After the coal has been undercut in rooms in the hand-loading sections, three 1½-in.-diameter holes are drilled into it to a depth of 5 ft. – one hole in the center of the coal, one in the rib to the left of center, and one in the rib to the right of center. The holes are loaded with 1⅛ by 8-in. cartridges of Hercules Red H°C permissible explosives on a ratio of 1 lb. of explosives to each 11 tons of coal in place. The charge in each hole is primed with a Hercules° No. 6 Electric Blasting Cap with 7-ft. iron leg wires. Damp earth or limestone dust packed into 1½ by 12-in. paper containers is used to stem each hole to the collar. The three loaded holes are fired separately – the center hole first, followed by each of the two rib holes – using a dry-cell single-shot-firing battery.

In rooms in the mechanical loading sections, no tracks are laid and the blasting procedure is slightly changed. The three holes drilled into the coal are 1¾ in. in diameter and 7 ft. deep. The permissible explosives charge in each hole is primed with electric blasting caps with iron leg wires 10 ft. long. Blasts are fired with a Femco 10-shot firing unit.

The results from blasting are consistently satisfactory and a large percentage of lump sizes of coal is obtained. This is important to the successful operation of this mine, as the

Reg. U.S. Pat. Off.

PREPARING TO BLAST: Three holes are drilled into a working face, loaded with permissible explosives, and primed with electric blasting caps with 7-ft. iron leg wires. Only one hole is fired at a time – the center hole first, followed by each of two rib holes.



LUMP COAL: The results from blasting are consistently satisfactory and a large percentage of lump coal is obtained. The production of lump coal is important to the successful operation of this mine, as the bulk of customers' requirements is for this size.

RECOVERING THE COAL: In mechanical-loading rooms, the blasted coal is recovered by Goodman steel duckbills and transferred to telescopic conveyors which dump into 4-ton steel mine cars. Two electric locomotives haul the loaded cars to the mine portal.

bulk of its customers' requirements is for lump coal. No secondary blasting is required.

Recovering Blasted Coal

In the hand-loading sections, miners load the coal into 4-ton-capacity steel mine cars, which are hauled by 8-ton electric locomotives to a central gathering point. From there the coal is transported to the portal of the mine by two 10-ton electric locomotives hooked up in tandem.

In the mechanical-loading rooms, the blasted coal is recovered by Goodman steel duckbills and transferred to telescopic conveyors which dump into 4-ton steel mine cars. When loaded, the cars are hauled to the mine portal by two 10-ton electric locomotives. In some instances, the conveyors from four rooms empty their contents onto a main heading conveyor which, in turn, empties the coal into mine cars.

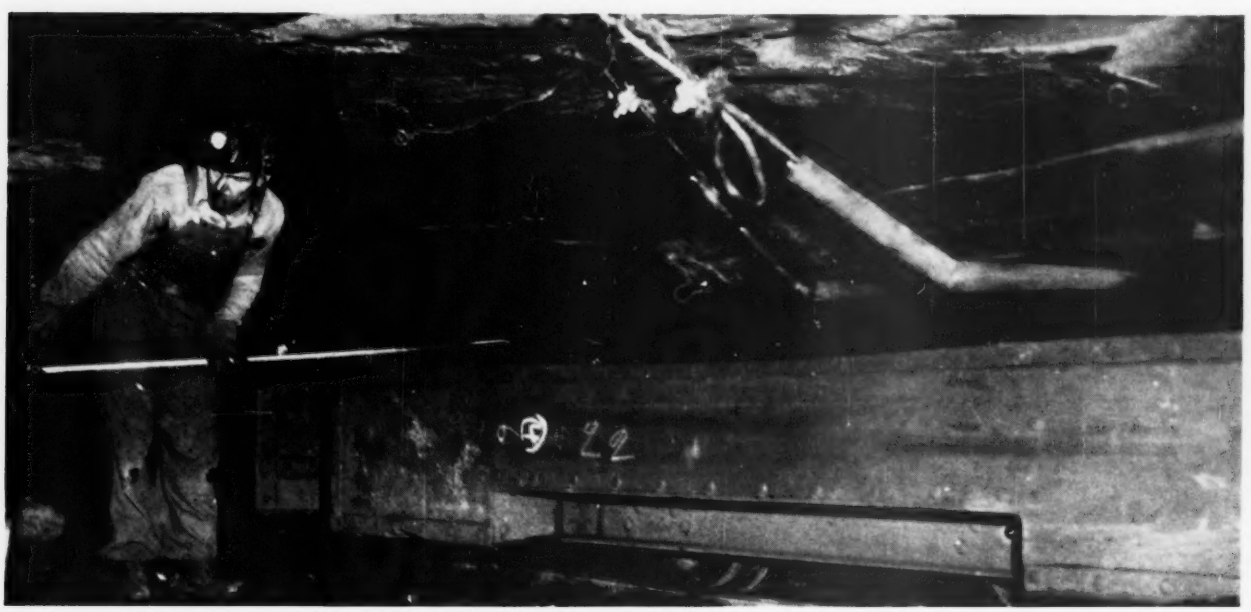
From the mine portal, six mine cars loaded with coal are lowered by a 500-hp. Nordberg hoist down a 4,500-ft. incline to the bottom of the incline. At the same time, six empty mine cars are raised up the incline to the mine portal to be returned to working places. An average of 12 trips of loaded cars is made down the incline every hour. This represents an average delivery of 288 tons of coal an hour at the bottom of the incline.

Unique Incline Hoist

This incline-hoist arrangement is said to be the second longest coal-transportation unit of its kind in the United States. Hoist operations require 4,360 ft. of wire rope, in one continuous piece, for each threading of the hoist. The life of the wire rope at this mine averages about nine months.

The hoist in use at Clover Splint mine was installed when the mine was opened in 1927. It has been in use since that time, with only a few minor repairs at infrequent intervals.

From the bottom of the incline, the loaded coal cars are hauled by electric haulage motors over weighing scales,

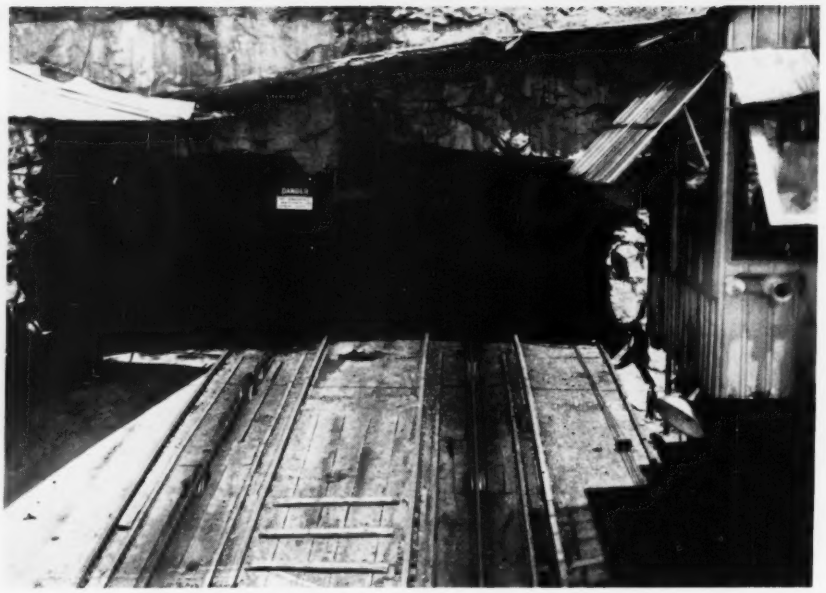


LOADING MINE CARS: The conveyors empty the coal onto a main heading conveyor which empties into the mine cars. In some sections, miners load the coal by hand into mine cars for delivery by locomotive to a central gathering room.

through a rotary dump, and into a bin. From the bin, the coal is moved through the preparation plant on several conveyors, passing over and through different sizes of screens, shakers, and crushers. This produces various grades and sizes necessary to meet the requirements of the company's consuming trade. The prepared coal is shipped over the Louisville and Nashville Railroad.

Equipment and Personnel

The principal equipment used in the Clover Splint mine includes a 14 BU Joy loading machine for rock excavation; cutting machines – a 34B and 17L Jeffrey and a 14B and a 14BB Sullivan; CP571 and CP572 Chicago Pneumatic electric drills equipped with 8-ft. twist steel augers; Goodman power duckbills, type 477; Goodman shaker drives, types G15 and G20; a 52B Jeffrey rubber belt conveyor, 30 in. wide; six electric haulage locomotives– a 711 General Electric and a 906 Westinghouse used in tandem, a 902 and a 904 Westinghouse, a 91A Goodman, and an 834 General Electric; two Mine Safety Appliance rock dusters – a face duster and a large, track-mounted unit for dusting the main-line haulageways; two Lee Norris mine jeeps, an MT12 (trolley) and a TJ1 (battery); a 5-hp. Sullivan and Brownie room hoist; and a 500-hp. Nordberg incline hoist.



MINE PORTAL: A view of the mine portal at the top of the incline. The inside set of rails is used for the barneys to travel on up and down the incline.

Closplint Coal Company's activities are under the personal direction of Charles D. Cole, president, and W. H. Shackleford, vice president and general manager. At Clover Splint mine, operations are under the supervision of Theodore Hensley, general mine foreman; W. A. Stout, maintenance foreman; Dewey Smith, chief dispatcher; J. E. Kelly, chief clerk; and Paul Cantrell, billing clerk.

EN ROUTE TO THE PLANT: From the mine portal, six mine cars loaded with coal are lowered by a 500-hp. hoist down a 4,500-ft. incline. Simultaneously, six empty cars are raised up the incline. Deliveries at the bottom of the incline average 288 tons of coal an hour.

IN THE BEGINNING

Dame nature, all-wise in devious ways,
Leached caverns 'neath mountain and plain,
And gave hints to man to imitate her
With tunnels to serve his domain.
So aqueducts chiseled by Greeks through the earth,
And catacombs under Rome's hills,
Or silver and gold in Nubian mines
Gave start to the miners' new skills.

With manpower the gage of energy spent,
Antiquity strangely reveals
That lever and wedge were mankind's first jack,
And logs formed the pattern for wheels.
How patient must man have been in those days,
When chisel or flint were the tools
That gouged out the tunnel, crypt, or the tomb,
For commoners, kings or their fools.

But questions remain unanswered today,
The answers men never will learn;
Who dug the first tunnel—Roman or Greek?
How much did a good miner earn
When copper saws gnawed their way through tough rock,
Or tubes rasped a hole for a wedge?
Were safety rules taught to ten thousand men,
Who quarried with pick and a sledge?

Were "holing through" parties thrown in those days
When Frontius finished a job?
Did miners snub muckers, low in their caste,
Or shiftbosses drink with the mob?
Could Nero dare boast of progress or costs?
Did Claudius have a wild day,
With princes and senators seated on stage
When water coursed Appian Way?

Each age had its rulers, famed in their years,
For leadership, follies, or crime,
Each day saw wild dreamers or wise men who planned
Great projects in every clime.
With names of great lovers, sinners, and saints,
Fame's corridors ever have rung;
While songs of the heroes, emperors, kings,
Through centuries long have been sung.

But few are the praises given the men,
Grimed toilers, like moles in the ground;
Without them no temples ever could rise,
Or metal or prized gem be found.
Though gone are old kings, the prince, and the slave,
Dust scattered between the earth's poles,
The new crews come on to take up their tools,
On shift in Life's varying roles.

CHARLES F. THOMAS

Tungsten Mine

(Continued from page 44)

The results of long-hole procedure in flat back stopes were found to be fair. Such holes were drilled to a depth of 22 ft. The majority of ore blocks is now planned for ring drilling by diamond-drill methods.

Recovering Blasted Ore

After the ore has been blasted, it piles up in the bottom of the stopes and flows down to scram drift levels. From there it is slushed to Chinaman chutes by 50-hp. double-drum slusher hoists. Nine such hoists are in operation. These hoists load 11 tons of ore to the ore cars in 3½ minutes with optimum mucking, using a 48-in. scraper bucket. In addition to the slusher hoists, U.S.V. uses three mucking machines. These augment the hoists in draw points.

Once the ore cars are loaded, the ore is hauled 7,600 ft. to a rotary dumper by 10-ton, 250-volt D.C. locomotives. The rotary dumper unloads the cars direct to a hopper which, in turn, feeds to a grizzly.

When the ore has passed through the grizzly, it drops into a 42 by 48-in. jaw crusher, where it is broken to a 3½-in. size and discharged to a conveyor belt. The belt carries the ore to a 1,000-ton circular storage bin. Below the bin, ore is fed by pan feeders to 1¼-ton tram buckets in preparation for the long ride, via the aerial tram line, to the mill.

Originally the tram extended to A level. When the fire destroyed the tram station, the line was brought only to Zero level. When A level is worked again, the ore will be brought out at Zero level. The 4,800-ft. aerial tram line was built in 1941. The ore travels a smoother road to the mill than the one afforded the employes, for the buckets pass over the jagged ravines in straight descent. The minus 4-in. ore arrives directly at the mill's terminus and unloads automatically into a 300-ton wooden bin.

Mill Operations

The second part of the story centers around operations. The ore is fed by a pan feeder to a 32-in. rod-decked vibrating screen with ½-in. spacings.

FINISHED PRODUCT: A close-up of calcined calcium tungstate in United States Vanadium Company's Pine Creek mill, ready for the market.

The ore moves from here to a short-head cone. The total capacity of the fine-crushing operations is 800 tons per shift. From here a series of conveyor belts carry the ore up to one of four 1,000-ton-capacity circular steel bins, or to the stock pile. The storage bins release the fine-crushed ore as needed direct to four 6 by 5 low discharge ball mills. Each mill grinds 250 tons per day to 34 per cent minus 325 mesh. Ball consumption is 1¼ pounds per ton with a discharge of 70 per cent solids.

As the ore leaves the ball mills, it passes through four 60-in. classifiers. The classifiers overflow at 55 per cent solids and sand is returned to the ball mills for additional processing. The overflow moves to one of four identical rougher sections.

The rougher sections are arranged in parallel with 32 by 32-in. M.S. cells—eight for flotation and two for conditioning the scheelite flotation feed. Here the ore, passing through processing, can take one of two paths. The concentrate from these sulphide roughers moves into the sulphide cleaners and on through the mill to become molybdenite concentrate. The tailings from the sulphide roughers move to scheelite roughers to be processed into nodulized tungsten.

Processing the Concentrates

Because only one process can be followed at a time, we will first follow the concentrate through its processes. From the sulphide roughers, the concentrate proceeds to the sulphide cleaners. The cleaners are arranged in parallel with five 32 by 32-in. M.S. machines in each section. The machines operate on a two-stage cleaning procedure. Three cells are used in the first stage and two cells are used in the second stage.

The cleaned concentrate then flows into a 30-ft.-diameter thickener vat where it is heated to 60°C. The underflow is diluted to 10 per cent and the thickeners, operating in batch operation, feed through a three-disc filter. The filtrate goes back for additional processing, and the concentrate and cake move on to a 36-in. ball mill where the cake is ground at 70 per cent solids.

The ball mill moves the ore to the molybdenite roughers where the pulp, at 20 per cent solids, is sent to two banks of six cells each in 24 by 24-in. M.S. machines. The first bank produces

primary concentrates. The second bank produces scavenger concentrates. It then passes through eight stages of molybdenite cleaners in sixteen 24 by 24-in. M.S. machines. The tailings from each stage are returned to the previous step, and the tailings from the first stage return to the first bank of molybdenite roughers. The cleaners produce molybdenite concentrate and the tails from the scavenger cells produce copper concentrate.

To follow the tungsten through its processing, it is necessary to return to the sulphide roughers. The tailings feed into the scheelite roughers arranged in parallel. Each rougher has ten 32 by 32-in. M.S. cells. The sections are "hog troughed" by holes through the cell partitions to form groups of 4-2-2-2 cells in each of the four sections.

The scheelite concentrate from this rougher section is moved on to scheelite cleaners. The concentrate passes through a two-stage cleaning process. Tailings go direct to a series of tables.

The cleaning process uses five 32 by 32-in. M.S. cells in the first stage, and two such cells in the second stage. The tailings from this step go back to the scheelite roughers and the concentrate passes to a series of tables identical to the tailings. The difference between the tables lies in quantity. The concentrate passes over two tables; the tailings require four.

After passing over the tables, the concentrate table tailings go to a thickener, and the concentrate moves to a 36-in. ball mill, and then to a classifier. The overflow from the classifier is moved to the thickener where it joins the concentrate tailings.

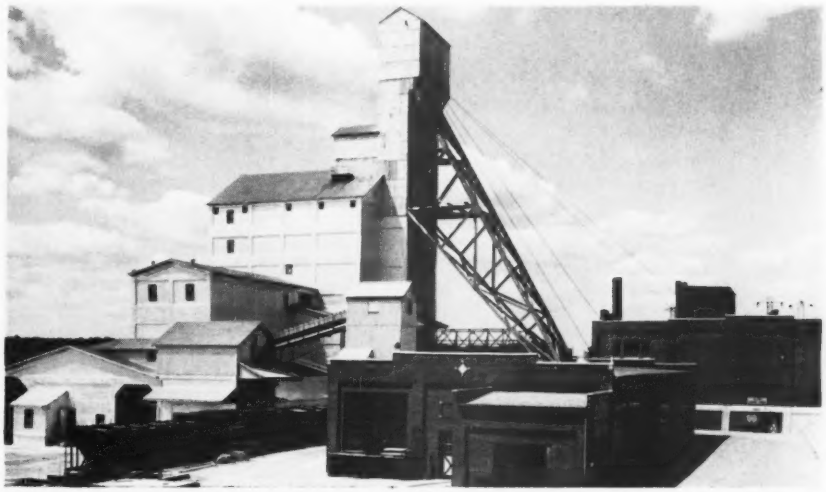
The thickener is 30 ft. in diameter and feeds into the chemical plant where the tungsten is separated from other elements. The calcium tungstate is then nodulized.

Housing and Personnel

With such progressive mining and milling procedures, it is obvious that United States Vanadium, a division of Union Carbide and Carbon Corporation, has faith in the future.

The company is continually trying to improve working conditions at Pine Creek. Housing, a problem during the war, is now easing. Employes live at Scheelite Village, a company housing project near the mill, and at Rovana Village, another company project at a lower level. Some occupy homes in nearby Pine Creek Housing Authority or in the city of Bishop.

The operating personnel at Pine Creek includes A. P. Cortelyou, general manager; H. L. McKinley, general superintendent; T. W. Holmes, mine superintendent; L. E. Sausa, mill superintendent; J. F. Emerson, chief mine engineer; T. R. Latham, mine foreman; Joe Cruz, aerial tramway and outdoor foreman; Nick Kurzeck, mill foreman; and A. A. Williams, transportation foreman.



THE BREAKER HOUSE: Designed for high-capacity production, the preparation plant at Retsof is operated entirely by electricity. It is the portal to the vast maze of salt galleries below.

Largest Salt Mine

(Continued from page 52)

two large scalping screens. The product from these screens passes through crushers to a battery of vibrating screens resulting in four basic sizes, finally reaching bins for further distribution to loading points.

International Salt Company ships salt in bulk and in bags by railroad cars and automobile trucks. The product covers a wide field of applications in industry such as in the making of steel, chemicals, food, clothing, leather, rayon, synthetic rubber, explosives, dies, for snow and ice removal, and in a host of other uses totaling more than one hundred.

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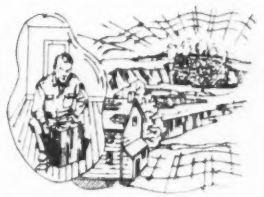

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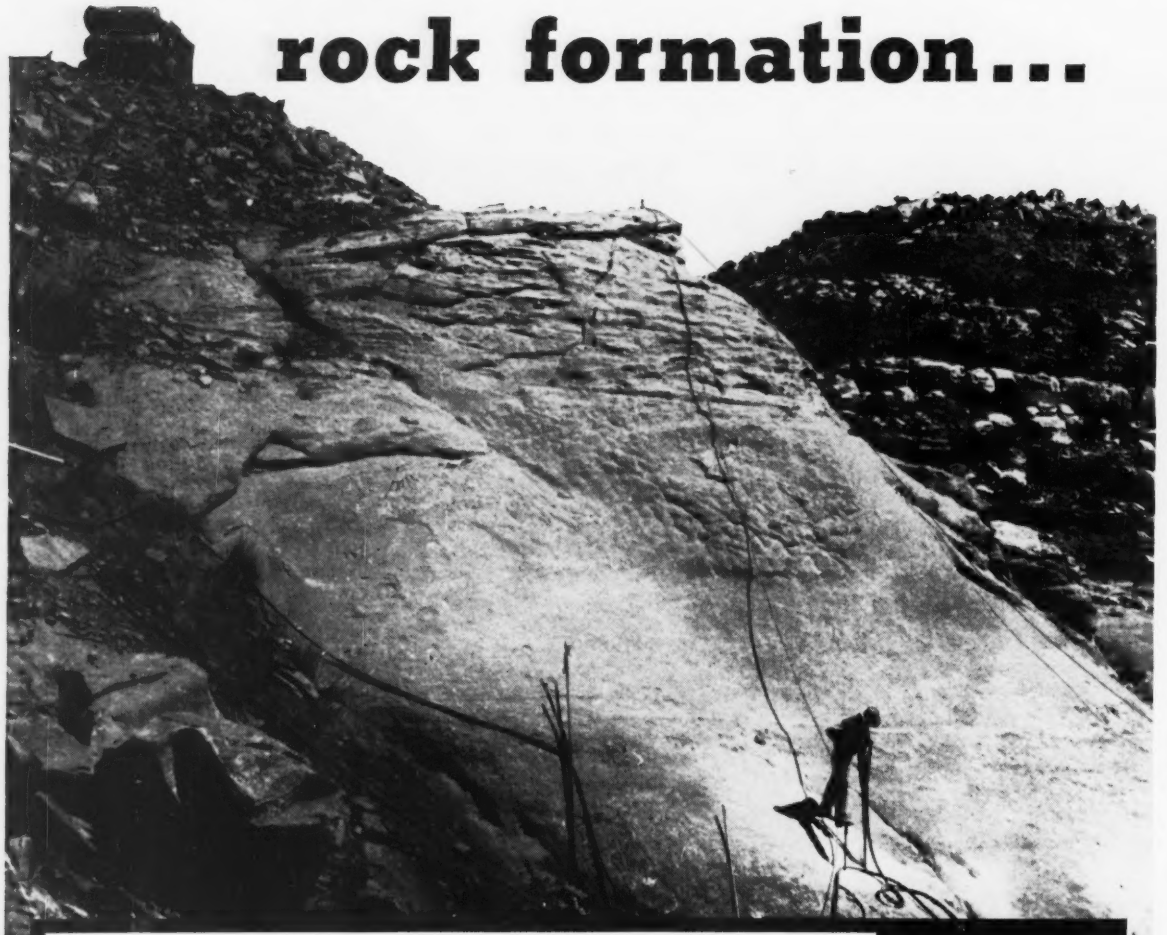

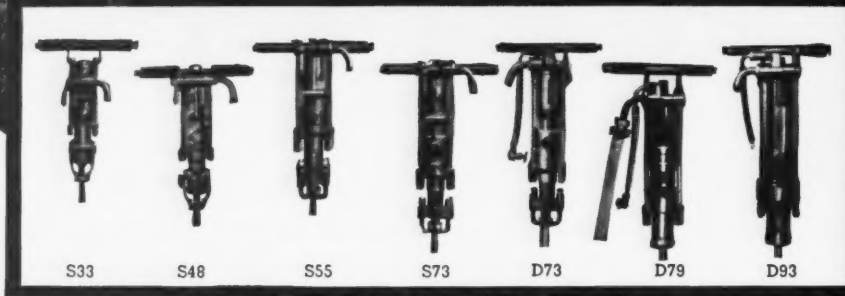

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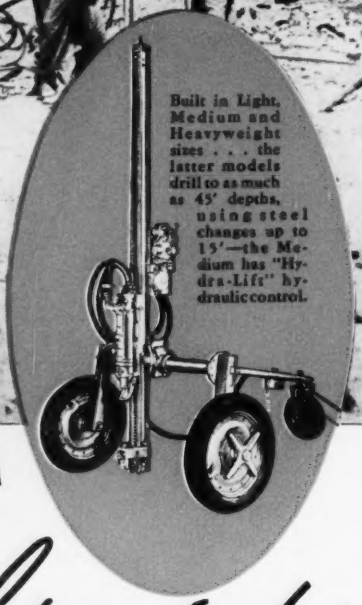

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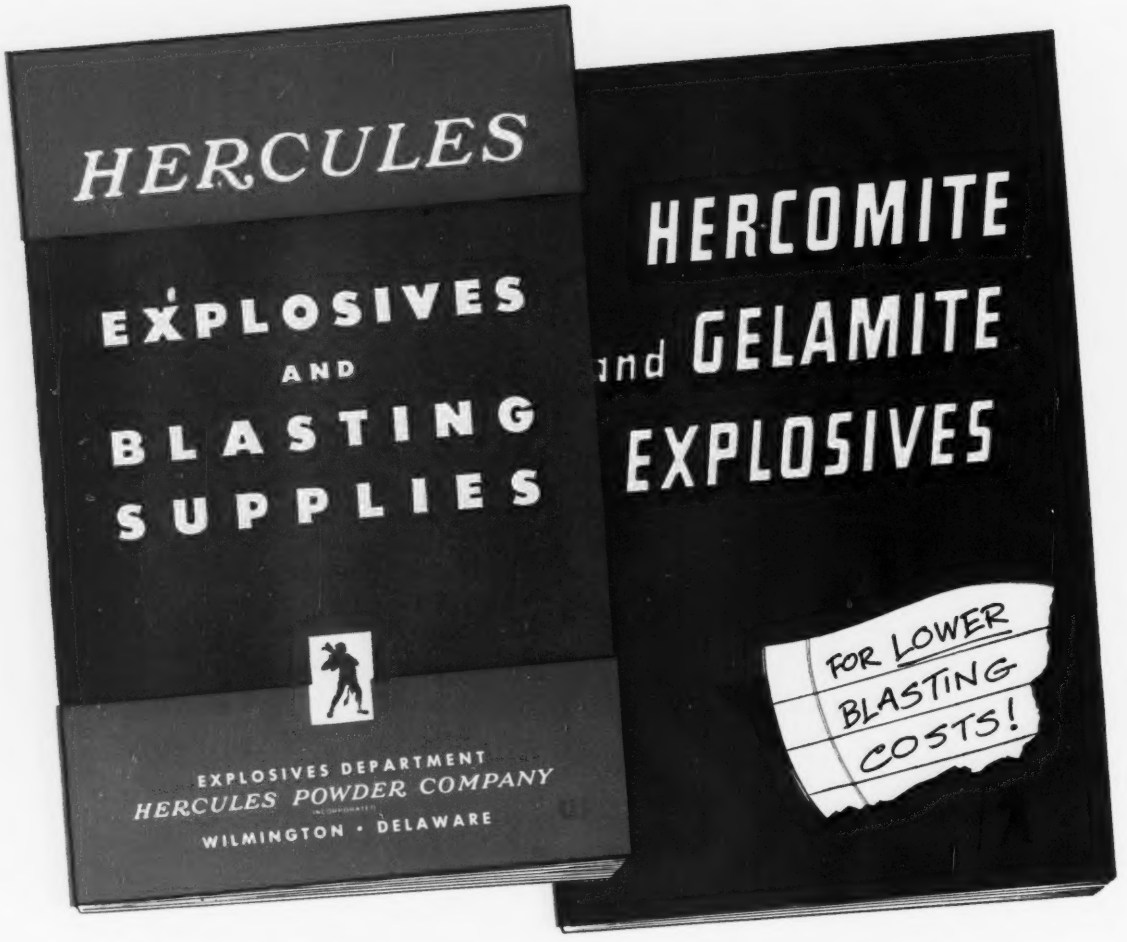

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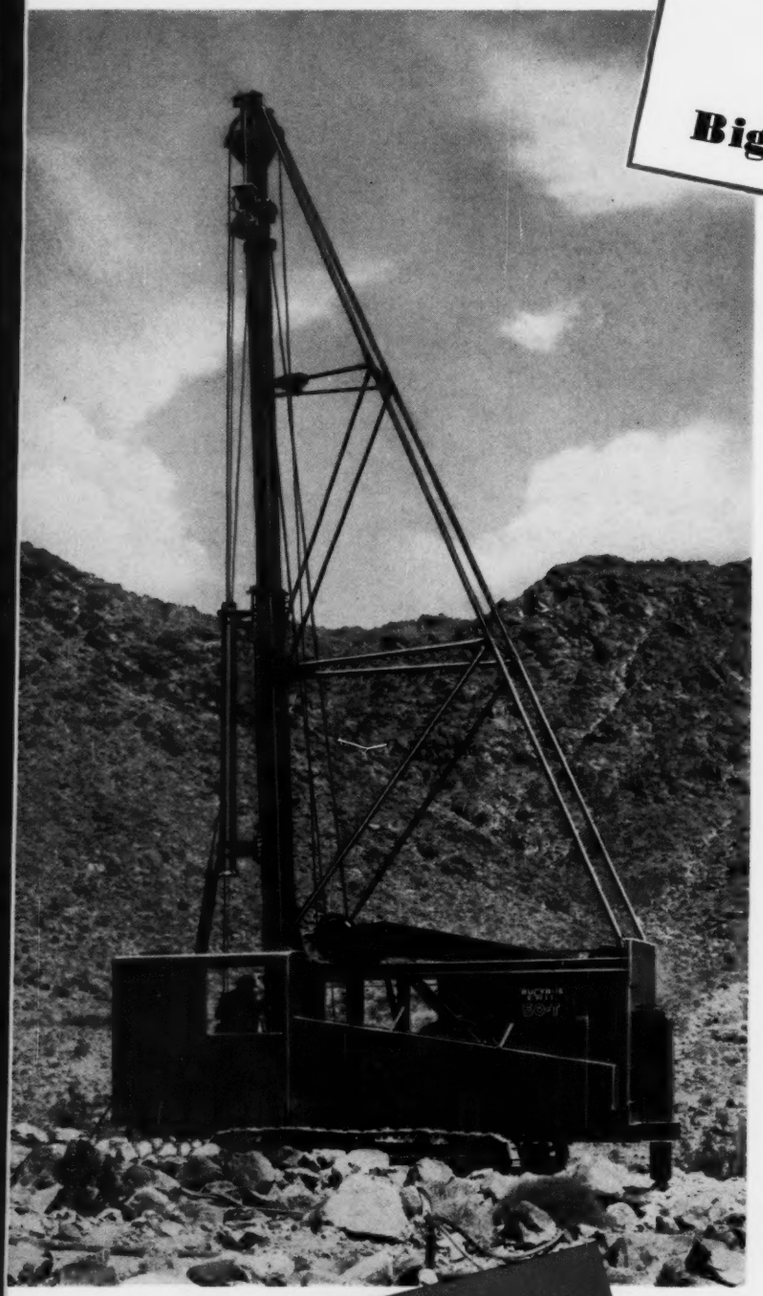

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